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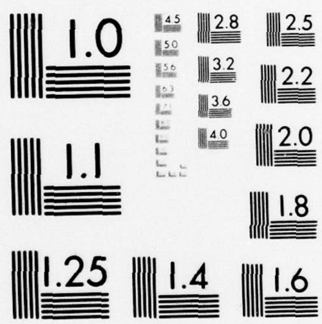
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A Digital-XBT Recorder
Titanium Alloys in Oceanographic Equipment

272 268

EXPOSURE

vol.6 no.5 a newsletter for ocean technologists

A DIGITAL-XBT RECORDER

Early in 1978, with the advent of "low-cost" microprocessor-based computers, it became apparent to the Technical Planning and Development Group, at Oregon State University, that concepts of data acquisition would be radically changing for certain marine research programs.

In one research program we recognized that a large number of expendable bathythermograph (XBT) profiles were going to be made to acquire data for later processing rather than adaptive on-site use of the data, similar to the way profiles are used by the fishing industry. Generally, in research programs where large numbers of XBT probe drops are made, the data handling problems become significant. With the Sippican XBT recorder system, there are two methods of digitally encoding the data for more effective data handling procedures: to digitize from the graphs or to purchase a unit with a built-in digitizer. The latter choice approximately doubles the hardware cost without providing a data storage medium. Either choice has the disadvantage of increased costs associated with personnel or hardware.

A research program that required multiple XBT profiles was chosen to explore the potential benefits of microcomputers to simplify the hardware, data acquisition, and data handling procedures in the program.

Utilizing a readily available microcomputer such as the Commodore "PET", and an interface which connects the microcomputer directly

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to an XBT launcher, as shown symbolically in Figure 1, we provide an XBT-digital recorder with the following features:

- A digital recorder package which costs less than $3,000.
- A system where the magnetic tape cassette has the only moving parts.
- Digitized data output without observer-to-observer differences.
- Versatility in adapting the operating characteristics to the desired task by just reprogramming in a high-level language (BASIC).
- Simplified operation for minimally trained operators.
- Capability for data compression and parameter scaling.

An interface (Figure 2) was built at OSU for connecting a PET to an XBT launcher, in the spring of 1978. The interface includes an A/D converter, analog interface circuitry for the XBT probe, and control circuitry which allows the PET to control various parts of the interface. The result is an interface circuit which requires minimal adjustment at assembly time and one which can be tested by the microcomputer.

The interface circuit resides in a box (see Figure 3) which attaches to the back of the PET, (see Figure 4) where it adds little to the volume of the microcomputer. The major strength of the digital XBT recorder resides in the computer software which has simplified system development, documentation, and adaptation of operations to special field programs. In fact, software development has occupied about half of the total recorder system development effort.

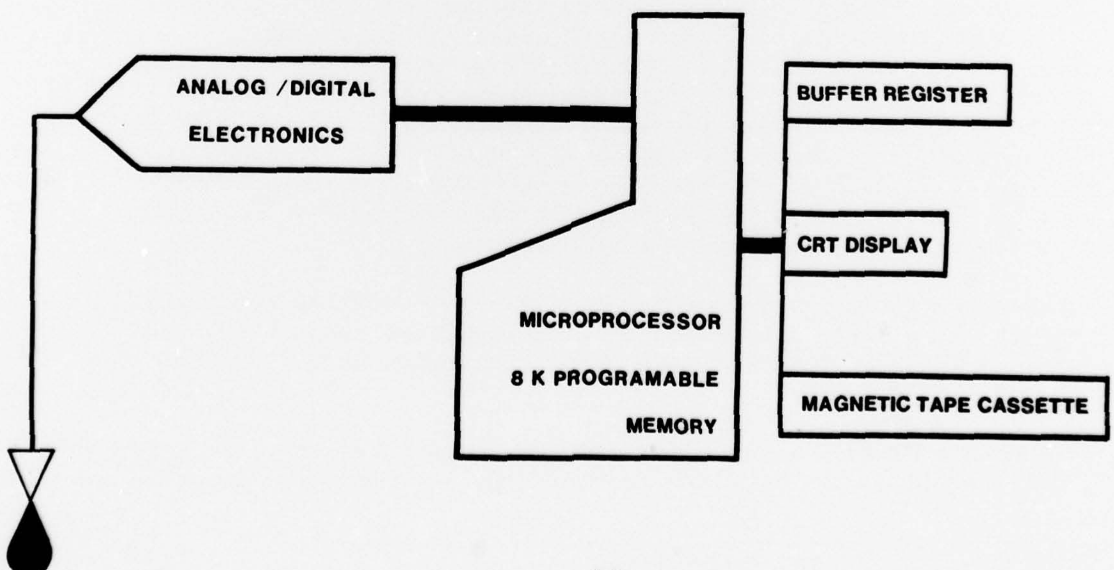

Figure 1. XBT DIGITAL RECORDING AND DISPLAY SYSTEM

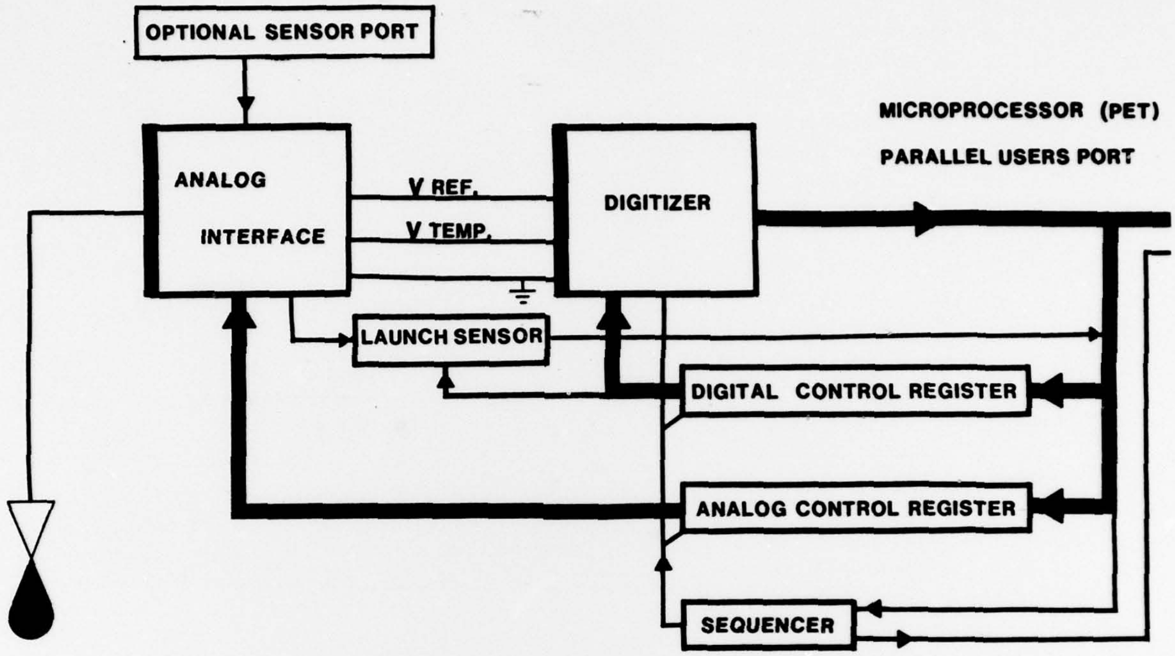

Figure 2. MICROPROCESSOR XBT INTERFACE

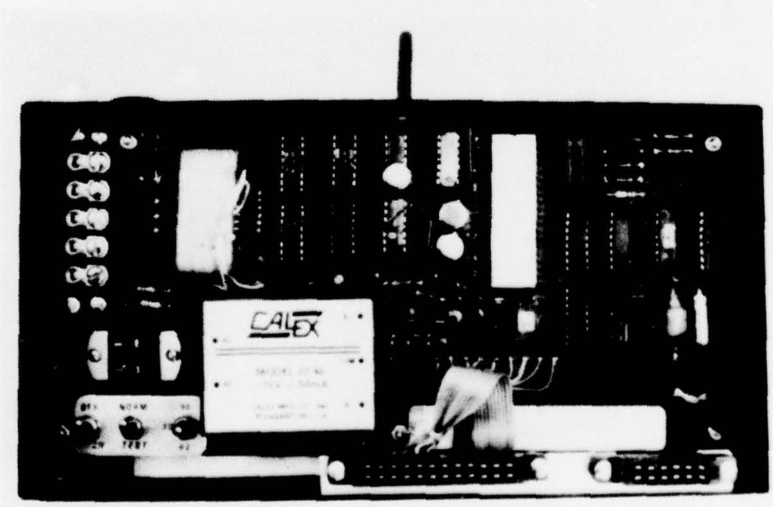

Figure 3.

XBT-Interface Circuit Board

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Attentive design consideration of software has made it possible to accommodate the desire to make the equipment "foolproof" while still providing for the user a high level of personal interaction.

The machine responds to the same stimuli (i.e., XBT canister in launcher, etc.) as the Sippican equipment and responds in approximately the same way. A graph is displayed on the CRT screen instead of being drawn on paper (Figure 5). Since microcomputers such as the PET have limited graphics capability, a vertically scrolling graph is used to provide operator verification of a successful probe drop.

Data tapes recorded on the PET may be read on the same unit. The data can be readily transferred to other data processing equipment via an RS-232 interface. These interfaces are commercially available for the PET, for less than $200, or they may be built utilizing the same scheme described by Dillon[1] for a PET 20-mA loop interface. The 20-mA loop can be fabricated for less than $100 in parts.

The first prototype of the digital-XBT recorder has had several sea trials. One trial (carried out by Scripps Institution of Oceanography) specifically compared the OSU unit to a standard Sippican unit and showed, after analysis, that the difference between the

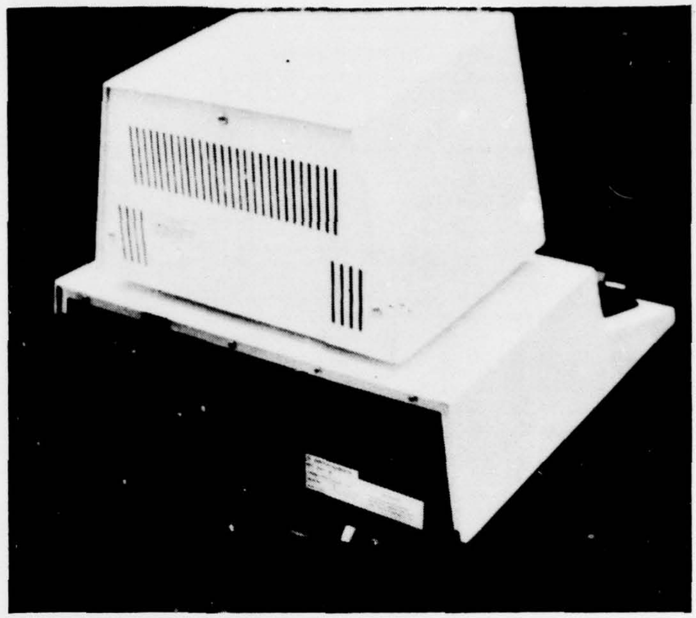

Figure 4.

XBT Interface Module Mounted to the Microcomputer

Figure 5.

Microprocessor CRT Graphics Display

[1] Exposure, Vol. 6, No. 4 (September 1978)

TABLE 1. SPECIFICATIONS

INPUT:	Sippican launcher cable. Launcher types LM-2A, LM-3A, or LM-4A may be used.	DISPLAY:	CRT "rolling chart" shows last 20 samples. Resolution 1/8°C horizontal by 1 sample vertically. No operator intervention needed.
PROBE:	Sippican T-4 standard (460 m). Others by software option.	RECORDER:	Audio tape. Records date and time of drop plus depth and temperature of each sample. Recorded twice for reliability. Approximately 22 probe drops on 1 side of 60-minute tape.
TEMPERATURE SCALE:	Celcius standard. Fahrenheit software optional.	DEPTH SCALE:	Meters standard. Feet, fathoms software optional.
TEMPERATURE RANGE:	-2°C to +35°C	DEPTH RANGE:	0-460 m. Other depths software selectable.
TEMPERATURE ACCURACY:	± 0.2°C	DEPTH ACCURACY:	± 2% or ± 5 meters
TEMPERATURE RESOLUTION:	.05°C approximate	DEPTH RESOLUTION:	depends on sample rate
SIZE:	22 inches deep x 18 inches wide x 17 m high	WEIGHT:	55 lb (25 kg) shipping
POWER:	115 V 50-60 Hz, 150 watts		

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two units was within XBT response specifications. This test involved thirty pairs of XBT probes, out of which twenty pairs were good probe drops. Table 1 shows the specifications for the OSU digital-XBT recorder.

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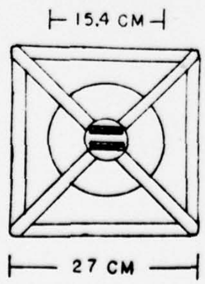
James Wagner is a member of the Technical Planning and Development group at OSU. He has a B.S. (physics) and a M.S.E.E. from OSU and a Ph.D. in electrical engineering from Colorado State University. His interests include analog and digital circuit design, filter synthesis, and interdisciplinary applications of electronics. He was formerly a design engineer at Tektronix and is currently working on ***in situ*** *conductivity instrumentation.*

TITANIUM ALLOYS IN OCEANOGRAPHIC EQUIPMENT



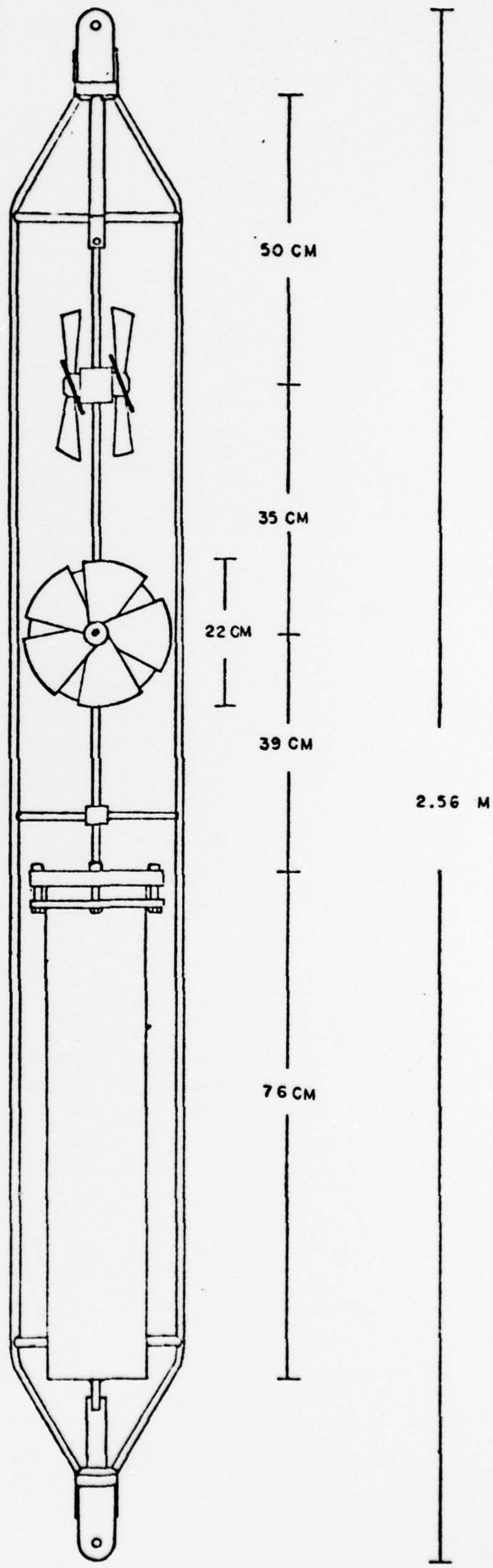


Figure 1.

Vector Measuring Current Meter

Research at the Scripps Institution of Oceanography has led to the development of a new current meter and hardware for mooring strings of these instruments in the deep ocean. In both the current meter and the mooring hardware, titanium alloy has been used. We have found that the use of titanium has several advantages over other materials and that the cost of material and and machining is not significantly greater than the cost of more conventional alloys such as 316 stainless steel.

The current meter was designed so that the load-bearing member was independent of the pressure case and sensor assembly. The load-bearing member also formed a protective enclosure or cage around the instrument, as shown in Figure 1. The cost of fabricating the load cage from stainless steel, Monel, and titanium was researched. Figure 2 compares the materials, cost, and weight of the assembly when fabricated out of each of the three alloys. Final bids on fabrication of titanium and stainless steel load cages were within $20 of each other.

The cage is made with all 6Al-4V titanium alloy; this alloy is used extensively in the aeronautical industry and is readily available from a number of sources in many raw stock configurations. The basic frame is 1/2-inch diameter rod with the end clevis machined from 2 1/2-inch bar stock. The four main cage rods are welded to the main rods. The cage is designed so that the current meter floats electrically and mechanically in its mounts and may be removed by pulling three small locking pins. It has an overall length of 99 inches, weighs 25 lb in air and has a conservative load rating of 10,000 lb. The prototype cage was tested on a large tensile test machine at a local engineering test facility. After an initial loading of 1,000 lb, the cage was repeatedly cycled to 10,000 lb and its overall elongation was measured at several loadings. The cage elongated only .125 inch or about .1 percent at 10,000 lb load. The cage was also coated with Stress-coat, a brittle coating that makes stress lines readily visible. At the conclusion of the tensile test, selected areas of the Stress-coated frame were photographed for evaluation. These photos showed the cage to have been lightly stressed with no areas of unacceptable stress concentrations.

Several high tension acoustic release frames, also of titanium, have been used repeatedly in the current meter moorings. Again, we were able to have a local manufacturer build the frames at a cost nearly identical to the stainless steel frame supplied

Figure 2. COST/STRENGTH COMPARISON

MATERIAL	316 ELC	MONEL K-500	6AL-4V Ti.
Ultimate tensile strength	79 kpsi	176 kpsi	154 kpsi
Corrosion fatigue strength	13 kpsi	26 kpsi	88 kpsi
Weight of cage (in air)	20.5 kg	24 kg	11.3 kg
Cost to manufacture	$838	$912	$862

by a major acoustic release manufacturer. The frame is one-third the weight of a stainless steel frame, with higher strength and freedom from corrosion.

After 1 1/2 years of using titanium in our equipment designs, we consider it to be an excellent structural material for the marine environment. We have also found that its cost is not significantly greater than stainless steel and its many benefits far outweigh the small difference in price.

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Jim Parks has been a development technician at SIO for 8 years. He has worked in the areas of instrument design and development. His present work involves current meters and mooring operations.

Robert Weller has a Ph.D. in oceanography from SIO, where he is presently a postgraduate research oceanographer. Weller has been involved in instrument development and in the use of current meters in studies of upper ocean dynamics.

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